SPECIFICATION

TO WHOM IT MAY CONCERN

BE IT KNOWN, That I, Rick C. Stevens, a citizen of the United States, residing in Apple Valley, Dakota County, State of Minnesota have invented new and useful improvements in OPTICAL COUPLING of which the following is a specification.

FIELD OF THE INVENTION

This invention relates generally to coupling and, more specifically, to coupling and decoupling optical leads to each other while minimizing reflections and twisting of the optical leads.

CROSS REFERENCE TO RELATED APPLICATIONS

None

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

None

REFERENCETO A MICROFICHE APPENDIX

None

BACKGROUND OF THE INVENTION

One of the difficulties in optical coupling of the ends of optical fibers to each other is to avoid or reduce the back reflection at the junction between the ends of two optical fibers.

One of the methods to optically couple two optical fibers, while minimizing back reflections, is to square or dome the ends of two optical fibers and abut the ends against each other and place a gel, or other optical conducting substance, which has an index of refraction that matches the index of refraction of the optical fibers, between the two ends of the optical fibers. Unfortunately, in applications where an optical fiber has to be connected and disconnected the presence of a gel or liquid at the ends of the optical fibers not only hinders the connecting or disconnecting process but it is difficult to retain the optically conducting

substance between the ends of the optical leads during the connection and disconnection process. Therefore, a connection and disconnection process using a substance between the ends of the optical fibers, although reducing the back reflection, is generally unsuitable for coupling optical fibers that need to be periodically coupled and decoupled from each other.

Another method to optically couple optical fibers is angle coupling where angle cut faces are placed in a parallel condition to each other. Angle coupling reduces the back reflection between the ends of two optical fibers. In this method one cuts the ends of each of two optical fibers at a "coupling angle" that is a cut across an optical fiber, at an acute angle with the acute angle such that a reflected optical signal from the optical fiber is directed outside the optical fiber to thereby minimize the effects of back reflection. The method of angle cutting the ends of the optical fibers to produce optical fibers each having an optical end face located at a "coupling angle" and then aligning the optical end faces in a parallel condition reduces the back reflection . Unfortunately, angle cutting the ends also requires one to rotate the optical fibers in order to align the optical faces in a parallel condition to each other. This method of angle coupling is effective in reducing back reflections as well as providing a method wherein the optical fibers can be quickly coupled and decoupled since there is no gel or other substance that needs to be maintained between the ends of the optical leads. However, the rotation of the optical leads to produce alignment of the end faces of the optical fibers can introduce twist or kinks into the optical fibers.

In order to rotationally align the optical faces during angle coupling one can key the ends of each of the connectors holding the optical fiber so that when the optical fibers are separated and brought together the angle cut faces of the optical fibers are automatically brought into a parallel condition to each other and thereby reduce the loss of an optical signal transmitted across the junction of the angle cut faces. Unfortunately, rotationally aligning the ends of the connectors by rotating one or the other or both of the optical fibers can introduce

unwanted kinks and twists into the optical fibers as one rotates the optical fiber to bring the optical faces into an aligned condition.

The present invention provides a coupling apparatus for optical leads or optical fibers that allows one to quickly coupled and decouple an optical lead and at the same time eliminate the problem of twisting of the optical leads as well as the problem of back reflection at the optical junctions. The present invention uses two optical couplers, one optical butt coupler that remains in a coupled but rotatable condition with minimized back reflections, and another angle optical coupler, that can be quickly coupled or decoupled with the butt coupler including a rotation joint that allows rotation of the optical fibers without introducing twists and kinks in the optical leads.

SUMMARY OF THE INVENTION

Briefly, the present invention comprises an optical coupling apparatus and a method of optical coupling two optical fibers to each other where at least one of the optical fibers to be connected to another optical fiber is severed before the terminal end of the optical fiber to form two butt connectable severed ends in the severed optical fiber. One of the severed ends is mounted in one end of a rotationally member and the other severed end is mounted in the other end of a rotational member so that when the two rotational members are assembled into a rotational coupler the two severed ends of the severed optical fiber are in optical communication with each other though a rotateable butt connection. To reduce the back reflection between the butt connectable severed ends an optical conductive substance having an index of refraction matching the index of refraction of the optical fibers is placed between the two severed ends of the optical fiber. The severed ends of the optical fiber, which are in a butt connecting condition with respect to each other are thus in a condition to rotate with respect to one anther without a degradation of the optical signal therebetween.

Thus twist or kinks to the optical fiber are avoided since the rotatable coupling element allows the optical leads to rotate without twisting.

In order to provide for coupling and decoupling of the optical leads an angle coupler is formed by severing the optical fibers at an acute angle to produce angle cut terminal ends such that any back reflection therefrom falls outside of a optical coupling area between the two severed ends of the optical fibers. In order to rotationally orientate the angle cut terminal ends of the optical fibers an alignment guide is placed on the ends of each of the two optical fibers to allow an operator to rotationally align the angle cut faces of the optical fibers with each other. Thus the presence of the rotational coupler on at least one of the optical fibers allows one to rotate the optical lead without introducing kinks or twists and at the same time maintain the integrity of the optical connection through the optical fibers while the angle cut face alignment coupler allows one to quickly couple or decouple the optical fiber while minimizing back reflections.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a coupler for optically coupling an optical fiber to another optical fiber;

Figure 1A is an end view of the coupler of Figure 1;

Figure 2 is a perspective view of an alignment collar;

Figure 3 is a partial cross sectional view showing two optical connectors in a prearranged condition;

Figure 4 shows the two optical connectors of Figure 3 in an optical transmission mode; and

Figure 5 shows a sectional view taken along lines 5-5 of Figure 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figure 1 and Figure 3, reference numeral 10 identifies a three part rotatable coupling connector or rotateable coupler secured having one end secured to an optical lead or optical fiber 11. The rotatable coupler 10 includes a first flanged member 13 secured to the exterior surface of optical lead 11 and a second flanged member 14 located in a rotational relationship with respect to flanged member 13. Flanged members 13 and 14 are held in rotational engagement and alignment with each other by a U-shaped collar 12 that encompasses the flanges of members 13 and 14. A reference to Figure 3 shows the flanges 13a and 14a of the flanged members 13 and 14 of coupling connector 10 held in rotational engagement by collar 12 to form a rotational joint.

Figure 3 shows two identical rotateable couplers 10 and 30 in a condition for optically coupling optical fibers from two different sources. In the embodiment shown coupler 10 is shown in cross sectional view revealing flange 13a and flange 14a that are held in a face to face or an abutting condition by a U-shaped collar 12 to permit rotation of member 14 with respect to member 13. The optical lead 11 is fixed in member 13 and includes a butt connectable terminus or end 11a proximate a butt connectable terminus or end 17b. By butt connectable terminal or end it is meant that the terminal ends have an end face that can transmit an optical signal from one optical fiber to another optical fiber to form a butt coupled joint. To reduce the back reflection, an optical transmitting substance, which has an index of refraction that is substantially the same as the index of refraction of the optical leads 11 and 17 is located between and surrounds the optical leads 11 and 17. The presence of the optical conducting substance 22 that matches the index of refraction of optical leads proximate the ends 11a and 17b reduces the optical reflections thereby providing an optical

path from one optical lead 11 to the other optical lead 17 or vice versa with a minimum of back reflections.

Thus a feature of coupler 10 is that the member 14 is rotatable with respect to member 13 without disrupting the optical path from optical lead 11 to optical lead 17 while at the same time inhibiting or reducing back reflections. Coupler 10 also includes a rotational alignment member or elongated key 19 which extends axially along member 14.

Positioned proximate to coupler 10 is an alignment sleeve 25 which is shown partially in section. Alignment sleeve 25 has a lumen therein for receiving flanged member 14 and an inner surface 25a that mates with outer surface 14b of member 14 to coaxially align member 14 within alignment sleeve 25. Alignment sleeve 25 includes an alignment recess 25b that extends in an axial direction from end-to-end of alignment sleeve 25. The alignment recess 25b forms mating engagement with alignment guide 19 to prevent rotation of member 14 with respect to alignment sleeve 25. Similarly an alignment guide 19' on coupler 30 prevents rotation of member 14b' with respect to alignment sleeve 25. Thus member 19, member 19' and alignment sleeve 25 form a non-rotational coupler that maintains the angle cut end faces 17a and 32a in optical alignment with each other.

Figure 1A shows an end view of member 14 having a centrally located optical fiber 17 having an exposed optical angle cut face 17a forming a coupleable end. Optical fiber 17 is fixedly held in member 14 with member 14 having an axially extending alignment member 19 extending radially outward to from a rotational reference guide.

Figure 5 shows a cross sectional view taken along lines 5-5 of coupler showing optical fiber 17 having an outer surface 17c which is secured to member 14 to prevent rotation of optical fiber 17 with respect to member 14. Thus while optical fiber 11 is fixed with respect to

member 13 and optical fiber 17 is fixed with respect to member 14 the optical fibers 17 and 14 are rotateable with respect to each other through the rotational relationship of member 13 to member 14.

In the embodiment shown in Figure 3 a second identical optical coupler 30 is shown in cross section positioned proximate the opposite end of alignment sleeve 25. A first optical fiber 31 is rotationally coupled to a second optical fiber 32 through optical coupler 30, which is identical to optical coupler 10, to permit transmission of an optical signal from optical lead 31 to optical lead 32 through a butt coupled junction of optical faces 32b and 31a.

As can be seen in Figure 3 coupler 10 and 30 both carry alignment guides (19, 19')which can be brought into the alignment recess 25b by bringing the ends of coupler 10 and 30 toward each other in alignment sleeve 25. The alignment sleeve 25 allows the angle cut faces 17a and 32a, which are angle coupleable end faces, to be automatically brought into a parallel relationship, and hence a back reflection inhibiting condition, with each other by merely inserting the end of couplers 10 and 30 into the alignment sleeve 25 and bringing the ends of the couplers into proximity with each other.

Figure 4 shows the coupler 10 and coupler 30 located in an optically coupled end-to-end condition while held in rotational alignment with each other by the alignment sleeve 25. In this condition the optical angle cut face 17a and the optical angle cut face 32a are in a parallel or substantial parallel condition so as to transmit optical signals from end angle cut face 17a to end angle cut face 32a or vice versa. In the embodiment shown the angle end faces 17a and 32a are separated by a gap; however, since the optical faces are at a coupling angle the optical signal can be transmitted from one optical lead to the other optical lead with a minimum of back reflection. The optical angle cut faces 17a and 32a are referred herein as

a "coupling angle cut face". A coupling angle cut face as referred herein refers to the an angle cut across an optical fiber with the angle of the cut such that a reflected optical signal within the optical fiber is reflected outside the optical fiber so as not to interfere with transmission of optical signals between the two coupling angle cut faces with the angle dependent on the characteristics of the optical fibers.

While two rotational optical couplers 10 and 30 are shown for rotational connection of optical fiber 11 to optical fiber 31, a single rotational optical coupler can be used to provide an optical connection and at the same allow one to alleviate any kinks or twists in the optical leads since a single rotatable coupler can alleviate the twist or kinks in two optically connected fibers.

Thus, in the present invention one can quickly couple and decouple two optical leads to each other while at the same time inhibiting back reflections as well as eliminating kinks or twists in either of the optical leads.